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Are bigger governments better providers of public goods? Evidence from air pollution

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Abstract Theories explaining government size and its consequences are of two varieties. The first portrays government as a provider of public goods and a corrector of externalities. The second associates larger governments with bureaucratic inefficiency and special-interest-group influence. What distinguishes these alternatives is that only in the former is governmental expansion generally associated with an increase in social welfare. In the latter, the link between government size and public goods provision (or social welfare) is negative. We study the empirical significance of these competing claims by examining the relationship between government size and a particular public good, namely environmental quality (notably, air quality measured by SO_2 concentrations), for 42 countries over the period 1971–1996. We find that the relationship is negative, even after accounting for the quality of government (quality of bureaucracy and the level of corruption). This result may not prove conclusively that the growth of government has been driven by factors other than concern for the public good, but it creates a presumption against the theory of government size that emphasizes public good provision.

Keywords Government size · Public goods · Corruption · Government quality · Environmental quality · SO_2 concentrations

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1 Introduction

Governments around the world grew considerably in size and scope during the twentieth century, with the biggest acceleration occurring around 1960.[1] Tanzi and Schuknecht (2000) report that average government size in 17 industrialized countries (the ratio of government spending to GDP) grew by 22% between 1937 and 1960 but by 54% between 1960 and 1980. Since 1980, government size has increased much slower, with the government spending to GDP ratio in these 17 countries being only 6% larger in 1996 than in 1980.

Public choice and political science literatures offer several theories of government growth. These theories can be classified according to various criteria. A common classification is based on the distinction between demand-side versus supply-side forces or equivalently between citizen-over-state versus state-over-citizen considerations. Citizen-over-state theories rely on the premise that the size of government is demand-driven, thus it reflects the demand for government services (programs) by the citizens as a whole or by subgroups of them. The main theories within this category can, in turn, be divided into two subcategories: (a) the government as a provider of *pure* public goods and a corrector of externalities (Pigou 1932); and (b) the government as a provider of benefits to special interest groups (Olson 1965).[2]

State-over-citizen theories emphasize the supply-side determinants of government size and, in particular, the incentives of government bodies to expand beyond the level demanded by the citizens. While the main theories in this subcategory are usually divided into yet further subcategories, such as bureaucracy theory (Niskanen 1971, 2001) and the Leviathan theory (Brennan and Buchanan 1977, 1980), the logic underlying all of these theories and subcategories is similar. Governments as a whole or individual government agencies occupy a monopoly position in their respective polities. Hence, they are in a position to select the quantity and type of services they provide based mostly on their own preferences and objectives. There are many different ways in which governments can deviate from citizens' preferences in this respect. For instance, they may provide services demanded by the public but at a cost that exceeds the efficient level. Or they may bundle together public services with services that benefit themselves. In all of these cases, public goods provision, if it occurs at all, is a side issue.

The above classification suggests that there is only one situation where an expansion in the size of government is likely to be *unambiguously* welfare-improving for society as a whole; namely, when this expansion is demand-driven (citizen-over-state) and when it aims at the provision of a pure public good or the correction of an externality.[3] In all other cases, welfare is either decreasing as the size of government grows, or it is not possible to relate government size to welfare in an unambiguous way. Hence, devising an empirical test that

[1] Peacock and Wiseman (1961) argue that growth of government might be due to the existence of a ratchet effect in response to wars, with Higgs (1987) including any national emergency or economic crisis, in this theory. That is, once government spending increases due to a war or depression, it does not fall back to its original levels. Henrekson (1990), however, does not find empirical support for this hypothesis.

[2] While a third subcategory is often mentioned, namely the government as an executor of income-wealth redistribution (Meltzer and Richard 1981, 1983), it seems that this subcategory is not distinct but rather subsumed in one of the previous two. According to classical liberals, income redistribution belongs to the second, while according to socialists to the first category.

[3] It should be noted though that many externalities identified by governments are in practice not true externalities, and thus legitimate targets of government action. And second, even for correctly identified externalities, government intervention often makes things worse.

would provide information on the validity of the first theory against all of the remaining theories seems important for assessing the welfare implications of governmental growth.

A large body of literature has examined empirically components of the individual theories (Berry and Lowery 1987; Cameron 1978; Lowery and Berry 1983).[4] But there is no empirical work relating the size of government to the provision of public goods, in spite of the potential for this relationship to shed light on the various competing theories. In this paper, we attempt to study this relationship by examining the provision of a particular public good, namely environmental quality. We have chosen environmental quality because it is, by and large, a pure public good that can be identified and measured quantitatively. For reasons outlined below, we use sulfur dioxide (SO_2) concentrations as our measure of environmental quality. We examine the relationship between government size and SO_2 concentrations in 42 countries over the 1971–1996 period, controlling for important economic and political determinants of environmental quality. Our key finding is that this relationship is negative, that is, countries with larger governments tend to suffer more air pollution. Moreover, the relationship remains significantly negative even after accounting for the quality of government (measured by the quality of the bureaucracy and the degree of corruption).

Several caveats are in order. Finding that the size of government is negatively related to the reduction in a particular environmental bad (SO_2) does not prove that a similar relationship exists between government size and overall environment quality provision, or between government size and overall public goods provision (and moreover, that this is the case in each and every country in our sample). Regarding the first issue, Bernauer and Koubi (2009) show that most forms of air pollution (such as SO_2, CO_2, N_2O and NO_x) behave quite similarly across countries, so SO_2 is a reasonably good measure of air pollution in general. Regarding the second issue, one could argue that the only circumstances under which this finding would lack applicability to general public goods provision would be if there were strong substitutability between different types of public goods; a government that ignored environmental degradation could thus be one that placed great emphasis on education, health, or defense. This may well be the case and deserves further examination. But while awaiting the results of such studies, one cannot escape the conclusion that our findings do create a presumption against the theory of government as a provider of public goods and corrector of externalities.

The remainder of the paper is organized as follows. Section 2 develops competing theoretical propositions. Section 3 describes the data and the empirical methodology. It also presents the empirical findings. Section 4 concludes.

2 Theory and propositions

2.1 Citizen-over-state theories

The basic premise of this category of theories is that the size of government is demand driven. A large government can result from:

(a) Widespread externalities. The provision of educational or health services is a typical example of this claim.

[4] See Mueller (2003) for a comprehensive summary of the results of such studies.

(b) Differences in the elasticity between private and government goods. If government provides mostly services and if manufacturing is carried out mostly in the private sector, then the relative prices of government services will be increasing over time if the manufacturing sector is the primary location of productivity gains in the economy (as has always been the case). This is because the supply of manufacturing output will be increasing faster than that of services, which necessitates a price change in favor of services (Baumol 1967; Mueller 2003).
(c) A change in preferences over time in favor of public goods and services (Mueller 2003). Redistribution of income and wealth for social insurance purposes is an example of such goods. Rodrick (1998), for example, examines the risk (income volatility and employment) associated with open economies and finds evidence that open economies have larger governments.

The theory of government as a provider of favors to special interest groups originates with Olson (1965). By applying political pressure, such groups can obtain policies that have beneficial effects for the members of the group at the expense of society as a whole. While the actions of some of these groups may lead to a smaller government size (for instance, when business lobbies achieve lower taxation), empirically the net effect of the various interest groups in most countries seems to have been to increase government spending. For instance, Mueller and Murrell (1986) argue that when political parties supply interest groups with favors in exchange for their support, which have some spillover effects for other groups, government grows larger. They then present evidence in a cross-sectional sample of OECD countries for the year 1970 that the number of organized interest groups has a positive and significant effect on the size of government. Sobel (2001) also shows that there is a significantly positive relationship between political action committees (PACs) and federal spending in the United States: a 10% increase in the number of PACs in any period leads to an increase in US federal spending in the subsequent period by between 1.07% and 1.57%.

2.2 State-over-citizen theories

The basic premise of these theories is that the size of government is supply-driven. The two main versions, bureaucracy theory and Leviathan theory, emphasize the key role played by the government's monopoly position.

Bureaucracy theory According to Niskanen (2001), the key objective of government bureaucrats is to maximize the discretionary budget of their agencies, which does not preclude the possibility that useful public services are provided, but assumes that public agencies aim to hide their true costs. They thereby receive a larger total budget for less output and furnish public services less efficiently than if they had simply and passively responded to the median voter's demand. Chang et al. (2001), however, point out that an over-arching theory of bureaucratic behavior has yet to be agreed upon, because the many complexities involved in modeling bureaucracies, including their internal organization, the broad range of actors involved in various levels of decision-making, and a complex array of institutional interactions, make it exceedingly difficult to predict the performance and behavior of various government bureaucracies.

Leviathan theory Tullock (1959) describes how elected politicians can increase the size of the government by bundling together public and various private goods—such as policies that lead to personal financial gains, or to goods provision that increases their probability of reelection. Vote trading plays a crucial role in this process as legislators vote for other

legislators' pet projects in exchange for their votes on their own projects. The "earmarking"[5] practice of the United States Congress is a good example (see, e.g., Economist, "Lexington," January 19, 2006).

2.3 Proposition

Except for interest group theories, citizen-over-state theories claim that government is a provider of pure public goods and a corrector of externalities. Thus, public goods provision increases with government size. The state-over-citizen category of theories (bureaucracy theory, Leviathan theory) argues that the relationship between government size and public goods provision ranges from ambiguous to negative. Studying the relationship between government size and public goods provision may thus generate information that could prove helpful in assessing the validity of these competing theories.

3 Empirical analysis

Our empirical analysis focuses on environmental quality for two reasons. First, environmental quality can, to a large degree, be considered a pure public good: by and large, clean air and water can be enjoyed by most of a country's citizens. And consumption of such goods by one member of society does not reduce the availability of these resources for consumption by other members. The second reason is that environmental quality can be measured at sufficient levels of precision across countries and time to test the aforementioned theoretical claims quantitatively for a relatively large number of countries and years.

We begin by defining our measure of environmental quality and the independent variables to be used in this analysis, and then present the results of the statistical analysis.

3.1 Variables

3.1.1 Environmental quality: air pollution: SO_2

Our measure of environmental quality is air pollution, and in particular, sulfur dioxide (SO_2) concentrations. We have chosen SO_2 concentrations for several reasons. First, air quality is widely regarded as one of the most important environmental quality indicators and SO_2 is one of the so-called criteria pollutants used by the World Bank, the OECD, and numerous other national and international authorities to describe air quality.

Second, SO_2 is perhaps the most prominent form of air pollution worldwide, since it has direct effects on human health, ecosystems, and the economy.

Third, SO_2 can be controlled, if governments wish to, by altering the techniques of production.[6] In advanced industrialized countries, SO_2 is nowadays produced mainly by electricity generation and the smelting of nonferrous ores, whereas in developing countries and transition economies it is primarily emitted as byproducts of the burning of diesel fuel and home heating. While control of emissions is done via suitable regulations and taxes, the

[5] Earmarks are spending projects that are requested directly by individual members of Congress and are not subject to competitive bidding.

[6] Note that although SO_2 travels across borders, it is largely a national problem relative to other air pollutants, such as CO_2, which are global and their reductions require the cooperative efforts of many nations due to positive externalities.

design, implementation, and monitoring of regulations does require public resources (for instance, an environmental agency).[7] Although government spending on environmental issues is not large in the grand scheme of the public budget, still it is an instrument (from an econometric point of view) for spending on pure public goods. The point is that if higher government spending is driven by a government's desire to provide public goods (the theory of government as provider of public goods and corrector of externalities), then one should expect that this desire is also manifested in the better provision of the particular public good under consideration, namely, air quality. That is, high government spending accompanied by a low provision of environmental quality (after controlling for other determinants of air quality) is inconsistent with this theory.

Fourth, good data are available for a large number of countries and over long time periods (a serious problem in this type of research). Data for SO_2 *concentrations* are more reliable than data for other forms of air pollution, and it is also available for a rather large number of countries since the 1970s. Moreover, although one could argue that emissions data should be used since emissions are more closely linked to economic activity than concentrations, we chose to focus on ambient pollution rather than emissions because (a) it measures air quality more directly; (b) it is what citizens have preferences over and demand to be restricted as their income increases; (c) it is more appropriate for studies that examine the impact of pollution on human health and consequently voters' preferences for better environmental quality (Stern et al. 1996); and (d) the data themselves are of greater quality and reliability since they are collected and reported by international monitoring programs, while data on emissions come largely from national sources, and hence likely to be less comparable across countries.

Fifth, as shown by Bernauer and Koubi (2009), SO_2 is a meaningful measure of air pollution in general because various important forms of air pollution such as CO_2, N_2O, and NO_x behave similarly across countries and time. Some studies include several pollutants (Spilker 2011; Li and Reuveny 2006; Barrett and Graddy 2000). However, the problem with this approach is that data for different pollutants are available for different sets of countries and years. This renders comparisons of results across pollutants very difficult.

Our data for sulfur dioxide (SO_2) concentrations consists of annual observations (unbalanced dataset) for the years 1971–1996 from 42 countries. These data have been collected through standardized procedures in the framework of the Global Environment Monitoring System (GEMS)—see the Appendix for a list of countries and data sources, and Antweiler et al. (2001) for a description of the data. Following Antweiler et al. (2001), we use the logarithmic transformation of the median SO_2 concentration. The unit of measurement is micrograms per m^3.

3.1.2 Government size: government spending: gov.spending

Our measure of the size of government is the share of total, nominal (central) government expenditure in (nominal) GDP. This captures the share of national income that is directly administered by the government. Our data source is the International Financial Statistics database of the IMF.

Although we are interested primarily in the impact of government size on environmental quality, we need to control for a number of other factors that have been identified in the

[7] Naturally, the cost in terms of public resources may well differ across different measures (for instance whether a production quota is imposed or whether tradeable pollution permits are issued), but in general it will be nonzero.

relevant literature as important determinants of SO_2 concentrations. These additional determinants of environmental quality can be grouped in two broad categories: political and economic variables.

3.1.3 Political variable

Political system: polity Many authors (Bueno de Mesquita et al. 2003; Lake and Baum 2001; McGuire and Olson 1996; Niskanen 1997) have argued that nondemocratic regimes are likely to underprovide public goods, including environmental quality. The logic is as follows. Nondemocratic regimes typically are ruled by small elites that use the resources of their respective nations to create personal wealth and to redistribute income toward themselves. If the costs of stricter environmental policies are borne disproportionately by the elites (as would, for example, be the case with restrictions on polluting industrial activities) while the benefits are uniformly dispersed throughout the population, then these elites would have little incentive to implement such policies. In contrast, in democracies the median voter, who decides on public policy, faces a lower cost from environmental policies relative to the elites in nondemocratic regimes. This makes the adoption and implementation of stricter environmental policies more likely in democratic regimes.

Congelton (1992) also argues that a shorter time horizon for the policy maker leads to less stringent environmental regulations because many forms of environmental degradation develop slowly and over long periods of time (e.g., climate change, biodiversity, and air and water pollution). Given that authoritarian rulers tend to have shorter time horizons, Congleton concludes that democracies enact stricter environmental regulations than nondemocracies. On the other hand, one can argue that elected governments may have shorter planning horizons than nonelected governments because of the imperatives of the election cycle. Since the social costs of current economic behavior and political choices often materialize over the long term and burden future generations and future politicians, democracies may, as a result, undersupply environmental public goods relative to nondemocratic regimes where political leaders do not face frequent (re)election, and can take more costly decisions (stricter environmental policies) with longer term benefits without fear of being punished by myopic voters. Midlarsky (1998) makes a similar argument, noting that democratic governments may be reluctant to mitigate environmental problems because some groups are expected to lose (or gain) more than others when environmental policies are implemented.

Our measure for the political system variable is an index capturing the extent of democratic participation in government, *Polity*, from the Polity IV data set. Polity IV captures the competitiveness of political participation, the guarantee of openness and competitiveness of executive recruitment, and the existence of institutionalized constraints on the exercise of executive power. Polity ranges from -10 (mostly autocratic) to 10 (mostly democratic) (Marshall and Jaggers 2002). In light of the theoretical arguments, we expect the sign of the relationship between democratic political systems and environmental quality to be ambiguous.

3.1.4 Economic variables

In this paper, we follow Antweiler et al. (2001) in decomposing economic activity into scale, composition, and income factors in order to account for the different effects that income and production may have on environmental quality. In particular, we include:

Intensity of economic activity (scale effect): activity The larger the scale of economic activity is, the greater the level of environmental degradation (i.e., pollution) is likely to be. We measure the scale of economic activity by *GDP per square kilometer*, constructed by multiplying per capita GDP with population density (population/square kilometers). We expect a positive relationship between economic activity and environmental degradation.

Capital intensity of production (composition effect): capital The composition of economic activity influences environmental quality because different sectors of the economy affect environmental quality differently. For example, capital-intensive sectors, such as industry and especially manufacturing, may pollute more than either agriculture or services, depending on the form of pollution. We use the nation's *capital to labor ratio* to capture this element and expect it to exert a positive effect on pollution.

Income effect: income If environmental quality is a normal good—a popular presumption in the literature—one should expect a *negative* effect of per capita income on pollution. Following standard practice in the literature, we use a moving average of lagged income (a 3-year average of lagged GDP per capita).

Degree of trade openness: trade Some authors have incorporated international trade into their analysis of economy-environment linkages (Frankel and Rose 2005). They argue that trade affects the domestic economy and therefore also environmental behavior. The sign of this relationship appears to be ambiguous theoretically because of offsetting forces. Yet Antweiler et al. (2001) find that, at least for SO_2 concentrations, the net effect of trade is to reduce pollution levels. In this analysis, we measure a country's trade openness by *the ratio of the sum of exports and imports to GDP.*

3.1.5 Other variables

Weather conditions: precipitation We include the *variation of monthly precipitation*. Precipitation can affect (wash out) SO_2 concentrations. But if precipitation is concentrated in one season, then SO_2 concentrations over the year are not reduced. Consequently, we expect a positive effect of variation of precipitation on SO_2 concentrations.

Time trend: year We add a time trend to our regression analysis to capture the general trend toward higher environmental quality observed during the sample period. This variable controls for the existence of secular trends in income, capital intensity, and the concentration of economic activity.

3.2 Statistical model

Combining the variables discussed above, we obtain the following statistical model:

$$\begin{aligned} SO_{2kt} = {} & \beta_0 + \beta_1 * \{\text{government size}\} + \beta_2 * \{\text{political variable}\} \\ & + \beta_2 * \{\text{economic variables}\} + \beta_3 * \{\text{weather conditions}\} + b_4 * \text{year} + e \end{aligned}$$

where SO_2 is the log of the median of SO_2 concentrations in country k (averaged over the sites available in each country and year), at time t. $\beta_i = 1, 2, 3$ are the coefficients to be estimated. The model was estimated using the econometric technique advocated by Beck

Table 1 Summary statistics

Variable	Obs	Mean	Std. Dev	Min	Max
SO_2	470	−4.66475	0.9390087	−6.907755	−2.533603
gov.spending	430	0.2744851	0.1069232	0.0804436	0.5602798
polity	461	5.496746	6.919293	−10	10
corruption	397	4.649874	1.520344	0	6
bureaucracy	397	4.923804	1.464873	0	6
income	470	1.53756	1.456816	0.0123468	6.943756
activity	470	6.154907	7.385244	0.2244735	45.60468
capital	470	6.200937	3.297288	0.829223	17.18889
trade	470	0.5473649	0.3686311	0.0884	2.6174
precipitation	470	0.0119138	0.005856	0.0028094	0.0542036

and Katz (1995). We correct for panel heteroscedasticity and spatial contemporaneous autocorrelation, and address problems of potential serial autocorrelation by estimating a single AR parameter for all panels as Beck and Katz (1995:645) suggest. These results provide Prais–Winsten coefficients with panel-corrected standard errors.

Before reporting the results, it is necessary to discuss whether the estimated statistical model suffers from possible simultaneity bias. The main object of investigation in our paper is the causal relationship between government spending and environmental quality. Therefore, a simultaneity problem would arise in this relationship if factors that affected the size of government affected simultaneously the quality of the environment, and these factors were not included in the list of variables on the right-hand side of the regression equation. Although we cannot identify any such factors and know of no theory suggesting existence for one, we have included in the regressions a dummy variable which takes the value of 1 if a country has a ministry for the environment or an environmental agency and 0 otherwise. This variable is meant to capture any effects that omitted variables (i.e., the error term) affecting the environment may have on government size. We found that neither the estimated coefficient for government size nor its level of statistical significance was affected by the presence of this dummy variable.

3.3 Results

Table 1 reports relevant summary statistics and Table 2 shows the correlation coefficients for the variables used in the analysis.

As indicated by Table 2, some of our independent variables, in particular corruption, bureaucratic quality, polity, and income are highly, positively correlated. We thus consider the issue of multicollinearity using the variance inflation factor (VIF) diagnostic.

Model 1 in Table 3 reports the results from the regression of SO_2 concentrations on the explanatory variables described above.

The variable of principal interest is government size. The effect of government size on air pollution is unfavorable and quite strong, both statistically and quantitatively.[8] Although the

[8] An increase in the share of government spending in GDP by 10% is associated with an increase in SO_2 concentrations by 1.10 percentage points.

Table 2 Correlation coefficients

	envir	yg	polity	corrupt	bureau	income	activity	capital	trade	precipitat
SO_2	1.0000									
gov.spending	−0.0428	1.0000								
polity	−0.1062	0.3070	1.0000							
corruption	−0.0515	0.3912	0.6199	1.0000						
bureaucracy	0.0400	0.3358	0.6296	0.8774	1.0000					
income	−0.1863	0.0810	0.5234	0.5918	0.6641	1.0000				
activity	0.3269	−0.2916	0.2056	0.1995	0.3070	0.3411	1.0000			
capital	0.0604	0.2254	0.4682	0.3787	0.4278	0.4686	0.1308	1.0000		
trade	−0.0539	0.6996	0.1167	0.2098	0.1711	−0.1040	−0.2908	0.0977	1.0000	
precipitation	0.1972	−0.2223	−0.4641	−0.4842	−0.4523	−0.5213	−0.1798	−0.4959	−0.1959	1.0000

Table 3 SO_2 and government size (government spending). Prais–Winsten regression, heteroscedastic panels corrected standard errors

	Model 1	Model 2
gov.spending	1.863***	1.574**
	(0.6900)	(0.7210)
corrupt + bureau		0.0091
		(0.0339)
polity	−0.0305**	−0.0272**
	(0.0121)	(0.0125)
income	−0.1984***	−0.1777***
	(0.0516)	(0.0551)
activity	0.0566***	0.0559***
	(0.0087)	(0.0079)
capital	0.0653***	0.0597***
	(0.0203)	(0.0173)
trade	−0.5280**	−0.2761
	(0.2538)	(0.2238)
precipitation	−5.579	3.905
	(8.910)	(7.029)
year	−0.0680***	−0.0788***
	(0.0103)	(0.0097)
constant	129.71***	151.02***
	(20.48)	(19.44)
Obs	421	375
R-squared	0.6346	0.6531
Wald χ^2	118.61	162.99
Prob > χ^2	0.0000	0.0000

Standard errors in parentheses.
* significant at 10%;
** significant at 5%;
*** significant at 1%

unconditional relationship between SO_2 concentrations and government spending is negative (correlation coefficient −0.2548), once the control variables are included the relationship becomes positive. A possible explanation might be that higher income leads to both bigger government and better air quality, and thus once income is controlled for, all else equal, countries with bigger governments have worse air quality.

All coefficients for economic variables are statistically significant and have the expected signs (note that a negative sign indicates a favorable effect on air pollution, as the dependent variable captures the level of pollution). As a matter of fact, the results are very similar to those that have been reported in the literature before. Higher income translates into less pollution, while a larger scale of economic activity or higher capital intensity (manufacturing) tend to increase pollution. The net effect of international trade is to reduce pollution. Similarly, the time trend is negative, that is, air pollution has declined as a function of time. In line with previous studies, we find that democracy has a positive effect on environmental quality (Bernauer and Koubi 2009; Li and Reuveny 2006; Barrett and Graddy 2000).[9] We also experimented with other measures of democracy, such the dichotomous index of democracy developed by Cheibub et al. (2010), without any ef-

[9]Multicollinearity is not a problem since the mean VIF for the model is 1.67 and the VIFs for all variables are smaller than 0.06.

fects on the results reported above. We also looked at the interaction between democracy and government size. The coefficient of the interaction variable is positive, suggesting that if an increase in democracy is accompanied by an increase in government size, then this takes away some of the positive effects of democracy on the environment. Given, however, that the coefficient is statistically insignificant, we cannot infer that the best prospects for environment are associated with democratization which is not followed by an expansion in government size.

Moreover, since previous work has shown that the relation between income and air pollution is different for communist as opposed to noncommunist countries (Antweiler et al. 2001), we check to see whether the relation between government size and environmental quality differs between these two types of political regimes. We include in our analysis a dummy variable indicating whether a country has a communist regime. The coefficient is statistically significant at the 1% level and shows that a communist regime is detrimental to the environment. Finally, we examine the robustness of our results to inclusion of other "political" variables that are likely to matter for pollution. In particular, we include dummy variables indicating whether a country has a federalist structure or is a member of the OECD. We find that both OECD membership and federalist structure are associated with lower SO_2 concentrations (note, however, that while the estimated coefficient of the OECD membership variable is statistically significant at the 10% level, the estimated coefficient of the federal structure is statistically insignificant).[10] The relationship between SO_2 concentrations and government spending is quite robust. It is not affected by the inclusion of lagged dependent variables, nor when both year dummies and country dummy variables to control for time-specific and country-specific fixed effects are included.

Having established that government size has a negative effect on air quality, at least as far as SO_2 concentration is concerned, we now probe somewhat further to understand the possible sources of this association. Although citizens and interest groups might demand the goods and services provided by government, they are supplied by government agencies. Given that bureaucracies supply a level of activity rather than produce a specific number of units, Niskanen (1971, 2001) argues that oversight agencies cannot accurately judge the efficiency of the produced output. Moreover, because of the monopoly nature of most bureaus, funding agencies (i.e., parliament/Congress and the executive branch) lack comparable information on which to judge their efficiency. Finally, the mere existence of government with its bureaus and the principal-agent problems that come with it inevitably lead to corruption. Could it thus be that it is not government size per se that matters for the provision of environmental quality as a public good, but rather how inefficient and corrupt a government is?

Several authors (Goel and Nelson 1998; Scully 1991) show that corruption tends to increase with government size. Moreover, a number of empirical studies confirm that bureaucratic inefficiency and high levels of corruption are associated with low levels of investment, low levels of aggregate economic growth, and socially suboptimal government policies (Rose-Ackerman 1999). For example, Mauro (1998) and Tanzi and Davoodi (1997), based on cross-country comparisons, show that corruption alters the composition of government spending. Specifically, corruption shifts spending away from education, health, and maintenance of existing infrastructure, and toward public investment such as large public construction works and buildup of the military.

Bureaucratic inefficiency and corruption seem to contribute to environmental degradation too. According to the authors of the Environmental Sustainability Index (2005), which ranks

[10] Results are not shown here.

nations by environmental performance, bureaucratic inefficiency, and corruption are among the most highly correlated (among the 67 quality-of-life variables included in the index) with poor environmental quality. One possible explanation for this relationship might be that in very corrupt societies, government officials accept bribes in return for not enacting environmental regulations or enforcing environmental laws.[11] Moreover, Fredriksson and Svensson (2003) develop a model to study the interaction effects of corruption and political stability on environmental policy. They find that while corruption reduces the stringency of environmental regulation (they use an index for the agricultural sector alone), its effect disappears as political instability increases. Lopez and Mitra (2000) develop a formal model to investigate the effects of corruption on the relationship between income and pollution levels, and establish that for any level of per capita income, corruption leads to pollution levels that are always above what is socially optimal.

We have thus included a measure of government quality by including the sum of the indexes of corruption and bureaucratic quality in the regression alongside the government size variable. We use the corruption index and the bureaucratic quality index that have been constructed by Knack and Keefer (1995) based on data obtained from the International Country Risk Guide (IRIS-3). These indexes have been extensively used in previous work. They both range from 0 to 6, with 6 indicating low corruption/high bureaucratic quality and 0 indicating high corruption levels/low bureaucratic quality. That is, lower corruption scores indicate that high government officials are likely to demand special payments, and that illegal payments are generally expected throughout lower levels of government in the form of bribes connected with services such as import and export licenses, tax assessments, and so on. High bureaucratic quality scores indicate the existence of "an established mechanism for recruitment and training," "autonomy from political pressure," and "strength and expertise to govern without drastic changes in policy or interruptions in government services" when governments change. We expect that low levels of corruption and high bureaucratic quality lead to lower levels of SO_2 concentrations, that is, we expect a *negative* coefficient.

Model 2 in Table 3 shows that the inclusion of this variable does not change the results materially. The estimated coefficient for the government quality variable (corruption + bureaucratic quality) is statistically insignificant at any level of confidence. Nonetheless, the estimated impact of government size on air quality remains unfavorable. This result suggests that there are additional channels (besides the government size $\Rightarrow$ corruption, bureaucratic quality $\Rightarrow$ low public goods provision channel) through which a large government may have harmful consequences for the environment. The one that has been emphasized in the literature is special-interest-groups that support a large government in order to derive private benefits (Mueller and Murrell 1986). If the dominant special-interest-groups are not promoters of environmental quality, then such an association can emerge.[12] The finding of Bernauer and Koubi (2009) that labor union strength is positively associated with air pollution is consistent with this interpretation.

[11] Desai (1998) shows that corruption contributes significantly to environmental degradation in developing countries.

[12] Note, however, that there exist instances where interest groups promote environmental quality in order to sell their products. For example, Brandt and Svendsen (2004) argue that the US wind turbine industry advocated CO_2 reductions because it served their own interests.

4 Conclusions

Several theories have sought to explain the size of government and its consequences for public goods provision and social welfare more generally. These theories have very different implications regarding the welfare effects of government activity. If government exists exclusively in order to provide pure public goods and correct externalities, then larger government size implies a higher level of welfare. If governments' key function is, at least to some extent, serving the interests of individual groups at the expense of other groups, then the effect of governmental growth on social welfare is either negative or ambiguous.

These competing theories are difficult to test empirically because of controversies associated with the identification of pure public goods as well as optimal levels of their provision. In this paper, we have made a first attempt to evaluate the empirical relevance and significance of the theory that assumes governments to act primarily as pure public goods providers and correctors of externalities. We do so by examining the relationship between government size and the provision of environmental quality. The public good examine is air quality. We have found that the relationship is negative and quantitatively significant. More government spending as a percentage of GDP goes hand in hand with more air pollution. Importantly, this association is not affected by measures of governmental quality.

We have argued that this finding does not prove conclusively that government size expansion has been driven by concerns other than public goods provision. First, environmental quality is but one of the many public goods that may be provided by governments. Second, SO_2 pollution is but one form of air pollution, albeit an important one that tends to reflect general air pollution levels. Third, we do not have a concrete, empirically testable theory of the optimal level of pollution. Fourth, we need more refined theoretical arguments on how government size, democracy, corruption, and rent-seeking by special interest groups interact in influencing public goods provision. One hypothesis to be investigated further is that large government size in autocracies may lead to low levels of public goods provision primarily through corruption, whereas in democracies it may do so primarily through rent-seeking. Nonetheless, our finding creates a prima facie presumption against the theory of government growth that emphasizes benevolent public goods provision. In any event, more work examining the relationship between government size and other environmental goods is needed in order to establish the generality of our results.

Appendix

A.1 Country list

Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Czechoslovakia, Denmark, Egypt, Finland, France, Germany, Ghana, Greece, Hong-Kong, India, Indonesia, Iran, Iraq, Ireland, Italy, Japan, Kenya, Malaysia, Netherlands, New Zealand, Pakistan, Peru, Philippines, Poland, Portugal, South Korea, Spain, Sweden, Switzerland, Thailand, United Kingdom, United States, Venezuela.

A.2 Description of variables and data sources

The data set was constructed with data taken from the following sources:

SO_2 concentrations: log of the median of SO_2 concentrations at site j, city i, in country k, at time t; average from all sites for each country and year. *GEMS/AIR*, US Environmental Protection Agency (US EPA) (http://www.epa.gov/airs/aexec.html)

Government size: total nominal government spending divided by nominal GDP. International Monetary Fund, *International Financial Statistics*

Corruption: corruption index ranging from 0 to 6, with 6 indicating low and 0 indicating high levels of corruption. Knack, Steve and Philip Keefer (2006). IRIS-3: File of International Country Risk Guide (ICRG) Data. 3rd Edition, College Park, Maryland (http://ssdc.ucsd.edu/ssdc/iri0001.html/)

Bureaucratic quality: bureaucratic quality index ranging from 0 to 6, with 6 indicating high and 0 indicating low levels of bureaucratic quality. Knack, Steve and Philip Keefer (2006). IRIS-3: File of International Country Risk Guide (ICRG) Data. 3rd Edition, College Park, Maryland (http://ssdc.ucsd.edu/ssdc/iri0001.html/)

Polity: index ranging from −10 (mostly autocratic) to 10 (mostly democratic). *Polity IV* (http://www.cidcm.umd.edu/inscr/polity)

Income: 3-year average of lagged GDP per capita. The *Penn World Tables*, NBER (ftp://ftp.nber.org/pwt56/), and International Monetary Fund, *International Financial Statistics*

Activity: real GDP/km^2 (GDP/population × population/km^2). The *Penn World Tables*

Capital: capital to labor ratio (the amount of the physical capital per worker). The *Penn World Tables*

Trade: ratio of the sum of exports and imports to GDP. The *Penn World Tables*

Population: *Global Population Distribution Database*, The Consortium for International Earth Science Information Network (CIESIN) (http://grid2.cr.usgs.gov/globalpop/1-degree/description.html)

Precipitation: coefficient of variation of monthly precipitation (the standard deviation of monthly precipitation in a given year divided by the monthly precipitation average in that year). *Global Historical Climatology Network (GHCN)*, National Climatic Data Center of the US National Oceanic and Atmospheric Administration (ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/v1/)

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